

## LOAD-ASSIST ACTUATOR

### BACKGROUND OF THE INVENTION

[001] This invention relates in general to machine elements or mechanisms and, more particularly, to reciprocating or oscillating mechanisms. Most particularly, the invention relates to a load-assist mechanism for actuators. The invention also relates to a load-assist actuator for use in tilt and recline wheelchairs.

[002] Tilt and recline wheelchairs are well known. Such wheelchairs have a reclining seat supported by a frame. An actuator pulls the seat forward on a movable pivot axis as the seat is tilted rearward. Load on the actuator is greatest during the first 10-15 degrees of tilting motion. During this range of motion, the actuator is susceptible to overload. Overloading the actuator may result in the actuator's inability to tilt the seat or shorten the life expectancy of the actuator.

[003] What is needed is an assist mechanism that reduces the load on the actuator and thus increases its life expectancy.

### SUMMARY OF THE INVENTION

[004] The present invention is directed toward an assist mechanism that reduces the load on the actuator and increases its life expectancy. The assist mechanism comprises an assist element that is adapted to store energy to assist in moving an actuator member. The assist element is carried between two members. The members act upon the assist element to cause the assist element to store energy when the actuator member is moved in an extended direction and release the energy when the actuator member is moved in a retracted direction, whereby the retracted direction is opposite to the extended direction.

[005] Another embodiment of the invention comprises a frame, a seat, and an actuator for use in moving the seat relative to the frame. The actuator comprises an actuator member and an assist mechanism. The assist mechanism comprises an assist element that is adapted to store energy to assist in moving the actuator member. The

assist element is carried between two members. The members act upon the assist element to cause the assist element to store energy when the actuator member is moved in an extended direction and release the energy when the extension tube is moved in a retracted direction opposite the extended direction.

[006] Various objects and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiment, when read in light of the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[007] Fig. 1 is a perspective view of an actuator according to a preferred embodiment of the invention wherein the extension tube of the actuator is shown fully extended.

[008] Fig. 2 is a perspective view of the actuator shown in Fig. 1 wherein the extension tube is shown partially retracted in phantom line and fully retracted in full.

[009] Fig. 3 is an environmental perspective view of the actuator shown in Figs. 1 and 2 wherein the actuator is connected between a wheelchair seat and frame for tilting the seat.

[010] Fig. 4 is a diagrammatic representation in elevation of the actuator and wheelchair seat and frame shown in Fig. 3 wherein the seat is in an upright position.

[011] Fig. 5 is a diagrammatic representation in elevation of the actuator and wheelchair seat and frame shown in Fig. 3 wherein the seat is in a partially tilted position.

[012] Fig. 6 is a diagrammatic representation in elevation of the actuator and wheelchair seat and frame shown in Fig. 3 wherein the seat is in a fully tilted position.

## BRIEF DESCRIPTION

- [013] Now, with reference to Figs. 1 and 2 initially, there is illustrated an electromechanical linear actuator 10 having a reversible electric motor 12, gear box 14, and a ball nut and screw mechanism (not shown) housed within a fixed outer tube 18. Ball nut and screw mechanisms are well known to those of ordinary skill in the art, and further details concerning their construction and operation are disclosed, for example, in U.S. Patents No. 5,485,760 and 6,101,889, the disclosures of which are incorporated herein by reference.
- [014] Extending longitudinally from the fixed outer tube 18 is an extension tube 28, which includes an end fitting 29 that, in the illustrated embodiment, takes the form of a clevis. Other types of end fittings commonly used in linear actuator applications, such as externally threaded shanks, may also be employed.
- [015] The electric motor 12 activates the ball nut and screw mechanism through gearing (not shown) inside the gear box 14, causing a screw (not shown) to rotate about its axis within the fixed outer tube 18. A ball nut (also not shown) converts the rotary motion of the electric motor 12 and screw into linear motion, enabling the extension tube 28 to telescope relative to the fixed outer tube 18 between extreme positions, illustrated in the drawings.
- [016] A fixed stop (not shown), which could be carried on the fixed outer tube 18 or on the screw, may be provided to confront the ball nut at the point of full retraction to limit inward movement of the extension tube 28. The screw likewise may carry a stop (also not shown) adjacent its outboard end which is confronted by the ball nut at full extension of the extension tube 28 to limit outward movement of the extension tube 28.
- [017] The components and operation of the actuator 10 thus far described are conventional. Thus far, it will be seen that there is nothing to reduce the load on the actuator 10 or lengthen its life expectancy. It will be appreciated that, for the actuator

load to be reduced and its life expectancy lengthened, a mechanical assist 30 is provided. The mechanical assist 30 uses an assist element to reduce a load sustained by the actuator 10 to accommodate heavier weight limits and extend the life of the actuator 10.

[018] The assist element 32 is adapted to store energy to assist in moving the extension tube 28. Upon moving the extension tube 28 in a first direction to extend or retract the extension tube 28, the assist element 32 stores energy that assists in moving the extension tube 28 when the extension tube 28 is moved in a second direction opposite to the first direction.

[019] The assist element 32 may be in the form of a spring, such as the helical spring shown. The spring is adapted to be compressed to store energy when the extension tube 28 is extended. Upon retracting the extension tube 28, the spring expands and the energy stored in the spring is released or exerted to assist in retracting the extension tube 28.

[020] As shown in the drawings, the assist element 32 may be carried by the fixed outer 18 between two members that act upon the assist element 32 to cause the assist element 32 to store energy when the extension tube 28 is moved. The members acting upon the assist element 32 may be in the form of abutment members, such as the abutment members 34, 36 shown. In a preferred embodiment of the invention, one of the abutment members 34 is maintained in a fixed position and the other abutment member 36 is adapted to move responsive to movement of the extension tube 28. The fixed abutment member 34 is preferably fixed relative to the fixed outer tube 18. The movable abutment member 36 is movable relative to the fixed outer tube 18. Upon extending the extension tube 28, the movable abutment member 36 is moved to cause the assist element 32 to be compressed to store an assistive energy. Upon retracting the extension tube 28, the movable abutment member 36 is free to move to permit the assist element 32 to release the assistive energy, which assists in retracting the extension tube 28. In the embodiment shown, the fixed abutment member 34 is in the

form of a clamp, the movable abutment member 36 is in the form of a collar guide, and the assist element 32 is in the form of a helical compression spring located between the fixed abutment member 34 and the movable abutment member 36.

[021] The movable abutment member 36 may be adapted for movement by forming a connection between the extension tube 28 and the movable abutment member 36. This connection may be formed in any suitable manner. For example, one or more connection members, generally indicated 38, may extend between the extension tube 28 and the movable abutment member 36. As shown in the drawings, the connection members 38 may be in the form of cable assemblies. Each cable assembly may be comprised of a cable 40 having opposite ends, generally indicated at 42, 44. One end 42 may be fixed relative to the extension tube 28 and the other end 44 may be adapted to move relative to, and ultimately engage, the movable abutment member 36. As shown in the drawings, a clevis 46 may be fixed to the extension tube 28. The clevis 46 is preferably fixed to the extension tube 28 adjacent the end fitting 29. The fixed end 42 of the cable 40 may be attached to the clevis 46 so that the cable 40 extends from the clevis 46 beyond the abutment members 34, 36.

[022] As shown in the drawings, the fixed abutment member 34 may be provided with guides 50, through which the cables 40 may pass. The movable abutment member 36 may likewise be provided with guides 52. The cable 40 may likewise pass through these guides 52. The movable ends 44 of the cables 40 are adapted to move relative to the movable abutment member 36 as the extension tube 28 is extended and retracted, and ultimately engage and displace the movable abutment member 36 when the extension tube 28 is extended beyond a certain distance. Displacement of the movable abutment member 36 by the cables 40 causes the movable abutment members 36 to act upon the assist element 32 to cause the assist element 32 to store an assistive energy. An assist element 32 in the form of a spring would be compressed between the abutment members 34, 36 as the movable abutment member 36 is displaced upon extending the extension tube 28, as shown in Fig. 1.

[023] It should be noted that the cables 40, upon retracting the extension tube 28 beyond a certain distance, may extend beyond the movable abutment member 36, as shown in Fig. 2. It may be desirable to limit travel of the movable abutment member 36 when the cables 40 extend beyond the movable abutment member 36. This may be accomplished by use of a stop member 54, such as the O-ring shown on the fixed outer tube 18, to limit travel of the movable abutment member 36 relative to the fixed outer tube 18 and thus limit travel of the assist element 32 when the extension tube 28 is retracted so that the cables 40 extend beyond the movable abutment member 36.

[024] The actuator 10 is adapted for use in moving a reclining seat 58 relative to a wheelchair frame 56. More particularly, the actuator 10 is adapted for use in tilting the reclining seat 58 relative to the wheelchair frame 56. As shown in Fig. 3, the actuator 10 is adapted to be connected between the wheelchair frame 56 and the reclining seat 58. When the extension tube 28 is fully extended, as shown in Fig. 4, the reclining seat 58 is in a non-tilted position. When the reclining seat 58 is in this position, the assistive energy is at its peak. An assist element 32 in the form of a spring, as shown in the drawings, would be compressed between the abutment members 34, 36 when the reclining seat 58 is in the non-tilted position. Retracting the extension tube 28 tilts the reclining seat 58. The load on the actuator 10 is greatest when the extension tube 28 begins to retract from the fully extended position. Assistive energy stored in the assist element 32 aids in retracting the extension tube 28 and thus, aids in tilting of the reclining seat 58. Continued retraction of the extension tube 28 uses all the assistive energy. An assist element 32 in the form of a spring, as shown, would eventually decompress, as shown in Figs. 2 and 5, until no assistive energy remains. Further retraction of the extension tube 28 moves the movable ends 44 of the cable 40 well beyond the movable abutment member 36, as shown in Figs. 2 and 6. The stop member 54 limits travel of the movable abutment member 36. As shown in the drawings, the stop member 54 keeps the assist element 32 and the movable abutment member 36 in place until the extension tube 28 is once again extended.

[025]        The principle and mode of operation of this invention have been explained and illustrated in its preferred embodiment. However, it must be understood that this invention may be practiced otherwise than as specifically explained and illustrated without departing from its spirit or scope.